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Ochieng, E.G.[1], *Ovbagbedia,O.O.*[2], *Abdulai, R.*[3], *Matipa, W.*[4], *Zuofa, T.*[5], *Ruan, X.*[6] *and Oledinma, A*[7]

[1, 7]*Cranfield School of Management, Innovation and Process Management, Cranfield University Cranfield, Bedford, MK43 0AL,UK*
[2, 4] *School of the Built Environment, Liverpool John Moores University, Byrom Street, Liverpool, L3 3AF, UK*
[3] *School of Architecture, Planning and Landscape, Newcastle University, Newcastle upon Tyne NE1 7RU, UK*
[5] *Faculty of Engineering and Computing, Coventry University, Coventry, CV1 5FB, UK,*
[6]*Bristol Business School, University of the West of England, Bristol, BS16 1QY, UK*

Corresponding author
Dr Edward Ochieng: PhD, PGCertHE, MSc, BSc (Hons), FHEA
Phone: +44 01234 751122 extn. 3123
Email: e.g.ochieng@cranfield.ac.uk
Edward is a Senior Lecturer in Programme and Project Management at Cranfield University, UK. Edward's research is focused on heavy engineering project management. He has extensive experience and knowledge relating to organisational challenges and solution development for managing large capital and heavy engineering projects. Edward has published 3 books, 28 book chapters and over 75 refereed papers in refereed journals and conferences. He has supervised 9 PhD students to successful completion and over 150 MSc/MBA industrial projects by research. He has also acted as an internal and external examiner of more than 10 PhD students in different UK universities.

Dr Oghenemarho Omaruaye Ovbagbedia: BSc (Hons), MSc, PhD
Email: m_omaruaye@yahoo.com
Phone: 001 8327458614
I have recently completed my PhD in Project Management at Liverpool John Moores University. My research interests focuses on knowledge management, risk management and people issues.

Dr. Raymond Abdulai: PhD, MPhil (Cantab), PGCertHE, BSc (Hons), MRICS, MGhIS, FHEA
Email: Raymond.Abdulai@ncl.ac.uk
Raymond is a Senior Lecturer in Real Estate and Urban Development at Newcastle University, Newcastle upon Tyne, UK. His research interests span various facets of real estate including: real estate securitization, economics, investment, valuation, management, finance and development; emerging real estate markets; and landed property rights in, especially, the developing world. Raymond has published extensively in these areas. He is the Editor-in-Chief of Journal of International Real Estate and Construction Studies, indexed in Cabell's Directory of Publishing Opportunities in Economics and Finance. He has successfully supervised eight PhD and two MPhil students and has examined 10 PhD students at various universities.

Dr Wilfred Matipa: PhD, PGCE, MSc, BSc (Hons)
Email: W.M.Matipa@ljmu.ac.uk
Phone: +44 0151 231 2860
Wilfred is a Senior Lecturer at Liverpool John Moores University. He holds a (BSc) Degree in Building (with Merit); and a Master of Science (MSc) (with Distinction) in Construction Project

Management. His Doctor of Philosophy Degree (PhD) in Civil and Environmental Engineering was obtained from Cork (University College Cork, UCC). Wilfred is a Chartered Builder (MCIOB) with an interest in research related to whole life cost management using information and communication technologies such as building information models (BIM) and computer aided taking-off (CATO).

Dr Tarila Zuofa: BTech, MSc, PhD
Email: ac5294@coventry.ac.uk
Phone: +44 75321023300
Tarila is a Senior Lecturer at Coventry University. Tari, has extensively carried out industry and academic oriented research in project management, most of which have focused on key issues such as strategic project management, risk and uncertainty management, knowledge management, multicultural team leadership. His PhD research explored a wide range of issues affecting risk management in the oil and gas industry and project management in general. Part of the novelty of the thesis was highlighted in its uniqueness of providing an excellent opportunity for exploring project management practices in developing and developed countries.

Dr. Ximing Ruan: MBA, PhD, MAMP, FHEA
Email: x.ruan@uwe.ac.uk
Tel: +44 (0)117 32 83182
After working in IT and the construction industry for 10 years, I pursued degrees in Northumbria University at Newcastle upon Tyne, including an MBA from the Business School and a PhD in project management from the Built Environment School. I joined the Business Management department at UWE in 2012 after four year's teaching in Aberdeen, Scotland. I am a full member of APM (Association for Project Management) with both APMP and PQ qualifications.

Dr. Akunna Oledinma: PhD, MSc, BSc
Email: A.Oledinma@cranfield.ac.uk
Tel: +44 (0) 1234 752260
Research Fellow in Cranfield University. She has a PhD in Transport, MSc in Energy Studies and BSc in Transport Economics. Her career focuses on these streams: Supply Chain Strategy, Environmental Sustainability, International Development, and Project Management. She has worked in various organisations within the transportation, business and financial sectors for about 11 years including the United Nations Headquarters Department of Economic and Social Affairs under the Energy and Transport Branch. Her research interests are in supply chain strategy, natural resource governance and Energy. She has extensive knowledge in Oil and Gas issues national and international stakeholder management and has developed practical framework for stakeholder relationships between communities and their governments in Nigeria. Her most recent work involved the development of a food distribution model in Qatar.

Abstract

Purpose: This research examined the efficacy of knowledge management based systems and best practices that could be used to address operational issues in the oil and gas sector.

Design/methodology/approach: Given little was known empirically about the strategies and practices which contribute to improved performance, innovation and continuous

improvement in the oil and gas sector qualitative method was used. Semi-structured interviews were used to derive senior managers' constructs of project delivery efficiency and knowledge management based systems. The interviews were analysed through the use of a qualitative analysis software package NUDIST NVivoTM. Participants were selected using purposive sampling. Validity and reliability were achieved by first assessing the plausibility in terms of already existing knowledge on some of the operational issues raised by participants.

Findings: These were synthesised into a framework capturing seven-well defined stages. All these steps emerged as being related; they are comprised of independent variables. These steps were found to comprise of knowledge management technology approaches, knowledge management people approaches, knowledge management strategies and value enhancing practices.

Research limitations/implications: Although the findings are pertinent to oil and gas organisations, it will be important to conduct follow-up research validating the potential for using the results of this study to establish frameworks for knowledge and information management in different organisations and contexts. This will provide not only data about the validity of the framework in generic terms but will also generate additional data on the application of knowledge management strategy.

Practical implications: As shown in this study, successful knowledge management based systems require the aligning of business strategy, technology for knowledge management, project management operations with an enterprise-knowledge sharing culture. Such sharing requires managing the behaviour of project personnel such that knowledge transfer becomes part of the organisation's norm.

Social implications: The implementation of knowledge management based systems requires deliberate planning and action to create the conditions for success and put in place the strategy, leadership, goals, process, skills, systems, issue resolution, and structure to direct and exploit the dynamic nature of project work. The strategies proposed in this research cannot be expected to resolve all knowledge management issues in the oil and gas sector. However, their use defines an approach that is superior to the traditional approaches typically adopted and consequently merits far wider application.

Originality/value: The proposed framework presents a better way of optimising the performance of project-based operations thus enabling oil and gas organisations to reform their poor performance on projects and empower them to better manage emerging cultural challenges in their future projects. Reflecting on their experiences, the participants confirmed that the proposed knowledge management framework and its seven well-defined stages were central to the effectiveness of knowledge management in oil and gas operations. Although the scope of this research was restricted to projects in Nigeria and the UK, the geographical focus of this research does not invalidate these results with respect to other countries. The fact is that the oil and gas sector globally shares some common fundamental characteristics.

Keywords: Knowledge management systems, Knowledge integration, IT project management, Cross-cultural issues, Knowledge adoption, Decision making, Developing countries.

1.1 Introduction

In the oil and gas sector, project practitioners are beginning to take responsibility for managing knowledge as a means to create value on projects, but still the sector has continued to face several performance challenges. One common performance challenge in the sector is that there is too much data and not enough information (Feblowitz and Vesset, 2013). The digital oilfield, the price and performance improvements in the sensor technologies, and the availability of broadband networks have maximised the volume, variety and velocity of data in the energy sector (Feblowitz and Vesset, 2013). Recently, Abel *et al.* (2015) showed that most of the data relevant for geological interpretation of oil reservoirs entails visual data that have no formal denomination and are learnt through an implicit process during training and field experience. The process of standardising and implementing a knowledge management based system can be particularly difficult for oil and gas companies, which has often viewed key business-exploration, upstream and downstream production, refining as distinctly different (Ochieng *et al.* 2016). Creating a standardised knowledge management model, which entails people and technology approaches, can be challenging (Secchi and Camuffo, 2016; Siemieniuch and Sinclair, 2004). To successfully implement a knowledge management based system, key stakeholders from the core areas mentioned above must come together and participate in designing a knowledge management system that is broad enough to capture all of the assets. Having a well standardised knowledge management based system linked to various business and project functions allows centralised knowledge and oversight, while giving flexibility in implementation. Within the context of this study, a knowledge management based system is defined as an information data base designed to assist the sharing and integration of project data. It is worth noting that a knowledge management based system may be less automated in that they may require human activity in their operation (Ochieng *et al.* 2016). For many oil and gas organisations in developed and developing countries, achieving knowledge efficiency requires cultural transformation within the strategic, operational and project levels of the organisation (Wagner and Majchrzak, 2006). As established from the reviewed literature, the UK oil and gas sector is no exception when it comes to the gaps and shortcomings experienced as a result of efficiency related challenges of knowledge management and project delivery (De Wit 1986; Lang 1990; Oil and Gas UK 2015). With an estimated circa 65,000 jobs lost in the UKCS (United Kingdom Continental Shelf) from the beginning of 2014 to the third quarter of 2015, reduced activity levels and threats to the sustainability of this key industry in the UK, mainly due to the significant reduction of the

commodity prices. There has never been such an aggressive demand and urgent need for meaningful knowledge management based systems and efficiency improvement initiatives in the UK Oil and Gas industry (OGER, 2015). It is worth emphasising that, the oil and gas industry in the UK as a whole has made significant strides in how they operate and individual companies have shared best practices to ensure the advancement of the sector (OGER, 2015).

In contrast, the oil and gas industry in developing countries like Nigeria has been under pressure to evolve into a sector that is constantly changing to fit the needs of the broader context in which the operations are executed (IIedare 2007). Attitudes towards working have changed dramatically in recent years and there is currently much more emphasis on the application of innovative knowledge based systems. As oil and gas organisations in Nigeria define more of their activities as projects, the demand for innovative solutions grows, and there is increasing interest in reforming the project delivery process (Ekemena, 2011; Nwafor and Salau, 2009; Rabiu 2009). Based on this demand, this research focussed on examining the extent to which knowledge management people approaches and technology approaches could contribute to adding value in the delivery of oil and gas projects. The growing difficulties associated with accessing and leveraging technical knowledge have roots in the several ongoing trends, including demographics (Oyejide and Adewuyi, 2011; Rabiu, 2009; Chen and McQueen, 2010). For instance, about half of senior project management practitioners are expected to retire over the next fifteen years (Nwafor and Salau, 2009). This exodus can be viewed as a recruiting and training challenge, but it is also a tacit knowledge management challenge. The challenge for oil and gas companies operating in Nigeria is how to ensure that the remaining project management practitioners and the incoming generation of project management practitioners have access to the data they require, so they can avoid repeating lessons already learned. Accessing that data is time-consuming and tedious because traditional knowledge management systems are ill-suited. Local oil and gas organisations are finding it impossible to capture the value of information residing inside and outside their organisations (Okunoye and Karsten 2002; Oyejide and Adewuyi 2011). Ultimately, without a solution to the knowledge management challenge, senior project management practitioners will continue to waste valuable time and resources, to their companies' revenues and profits. Hence, this research aimed to:

- Examine knowledge management challenges and propose an integrated framework for managing knowledge repositories in oil and gas projects.
- Contribute empirically to the development and advancement of project delivery in the oil and gas sector by proposing a knowledge management framework. The

researchers, deviated from previous studies by embedding a systematic knowledge management platform which includes knowledge management technology approaches, knowledge management people approaches, value enhancing practices and strategies and practices.

- Build on previous works specifically done by Leavitt (2002) and Grant (2013).

There is a review of knowledge management, evolution of oil and gas and perspectives of knowledge management in the next section.

1.2 Conceptual framing of knowledge management

Knowledge has been progressively considered the most important asset of organisations. Asrar-ul-Haq *et al.* (2016) referred to it as lifeblood of organisations and it has also been identified as a fundamental element required for the survival of organisations in dynamic and competitive times. Irrespective of the significant role knowledge plays within organisations, it is much more difficult to define because numerous possible interpretations are associated with the term. Theorising knowledge can be traced to antiquated studies (Ryle 1949; Polanyi 1967; Burrell and Morgan's 1979). However, more recently Karlinsky-Shichor and Zviran (2016) defined it as familiarity, awareness or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning. As established from the reviewed literature, several authors including (Shujahat *et al*. 2017; Karlinsky-Shichor and Zviran 2016; Geisler and Wickramasinghe 2015) have addressed the issue of emergence and key factors behind the increased interest in and application of knowledge management systems. Interestingly, these authors more or less identify the similar factors (Asrar-ul-Haq *et al.* 2016; Dalkir, 2011). One key feature identified in the literature is the substantial increase in international commerce and globalisation of businesses (Dalkir, 2011). Products manufactured in one organisation or countries are now assembled from multiple sources worldwide while in the past there were limited product alternatives. This trend has resulted in a more intensive competition for the survival of businesses. Another important feature has been the move towards leaner organisations and the challenge of delivering better, quicker and in time products and services (Geisler and Wickramasinghe 2015; Dalkir, 2011). The last feature relates to the constant need for highly skilled manpower, the increased turnover of employees and workforce mobility (Dalkir 2011).

As illustrated above, the discipline of knowledge management has equally emerged in both academic research and in practice over the years (Lang 2001; Leseure and Brookes, 2004). Although there are a lot of different definitions of knowledge

management, it can be said to improve organisational performance by allowing individuals to identify, take, share and apply their collective knowledge to make optimum decisions (Bjorkman *et al.* 2004; Gold *et al.* 2001; Nissen, 2005). An organisation must have “up-to-date” technology in order to develop globally, especially in the multinational business environment of today (Wagner and Majchrzak, 2006; Durcikova and Gray, 2009). However, to achieve bottom-line success, attention must be paid to the other issues. Experience in many organisations has shown that no more than one third of the knowledge management budget should be devoted to knowledge management technology (O’Dell *et al., 2000;* Bittner and Leimeister 2014*)*). One of the main success factors for knowledge management is to develop an understanding of the existing connections and mechanisms of sharing and then develop ways to allow people to improve on the already existing process (Gilbert *et al.*, 2002). According to Bixler (2002), implementing a knowledge management based system can be complex and dynamic, no matter how well planned and developed the organisation is, as it involves people and other organisational factors.

A lot of interest has been placed on knowledge in organisations and the idea has been recognised as a source of competitive advantage, this has been acknowledged by many authors such as Cao *et al.* (2013); Garavan *et al.* (2007). It was Nonaka (1991) who said that in an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge. In turn, when discussing knowledge management, it is necessary to make the following assumptions regarding knowledge: ‘knowledge is worth managing, organisations benefits from managing knowledge can be managed’ (Stewart *et al.* 2000; Mehta and Bharadwaj, 2015). Thus, Love *et al.* (2005) claimed that effective knowledge management based system could be considered as an instrument in a project environment for reducing project time, increasing product quality and to avoid making the same blunder. While all organisations may have a given knowledge repository within their organisation, they may be unaware of these resources as well as how to control them effectively to their advantage, therefore, senior project personnel must come up with ways and ideas to sustain and leverage these resources. These type of ideas and activities are known as knowledge management. Karlinsky-Shichor and Zviran (2016) defined knowledge management as the practice of selectively applying knowledge from

previous experiences of decision making to current and future decision making activities with the express purpose of improving the effectiveness of an organisation Knowledge management involves data mining and some method of operation to pass information to users (Amrit and Ephraim, 2005; Uday *et al.* 2006) and it is usually accomplished using a holistically combination of behavioural and organizational concepts as well as information management.

In recent times, the oil and gas industry has taken advantage of knowledge management (KM) developments (Leavitt, 2002; Grant, 2013) and the IT revolution (Wei 2009). So far, the industry has experienced swift transformations, throughout the rapid advance of technology, an extension of offshore drilling, numerous acquisitions, the growing reliance on foreign oil sources, and a focus on environmental issues, knowledge management initiatives have played a part in making operations more efficient and effective (Grant, 2013). Knowledge management is a key aspect of organisation capability that is critical in deploying best available resources (Rabiu, 2009). It is noteworthy, that every individual, society or organisation needs knowledge to be able to make real and sustained progress over time. Knowledge management teams provide support through technology and knowledge transfer, as well as asset management when an oil and gas organisation is faced with new technology, outsourcing, new partnerships, and government regulation (Ko and Dennis 2011; Li *et al.* 2012; Robert *et al.* 2008). When business issues involve capacity management, cost reduction, and the environment, knowledge management plays a part through forecasting/scheduling and process and technique innovation (Liu *et al.* 2010; Lyles and Salk, 2007; Jarvanpaa and Majchrzak, 2010).

According to Ichijo and Kohlbacher (2007) the success of a company in the twenty-first century will be determined by the extent to which its leaders can develop intellectual capital through knowledge creation and knowledge-sharing on a global basis. The importance of knowledge in economics, business and management has been recognised for quite some time. However, substantial attention to knowledge and its management as a source of organisational efficiency and competitive advantage is a recent phenomenon (Hung *et al.* 2015; Chen and McQueen, 2010). Recently, a lot of research emphasis has been place on knowledge management in

other parts of the world (Pawloski and Bick, 2012). Taking into consideration the existing state-of-the-art in knowledge management and organisational theory, there is evidence that a number of local oil and gas organisations in Nigeria involved in management of projects have placed little importance on knowledge management (Ekemena, 2011; Nwafor and Salau, 2009) while others have experienced very limited support from their knowledge institutions (Jegede *et al.* 2012).

1.3 Evolution of oil and gas: Knowledge management viewpoint

Oil and gas operations are so complex and multi-dimensional that major heavy engineering projects in many developing countries are often performed as joint ventures with firms from developed nations (Reid *et al.* 2001). According to Clark and Ip (1999), trans-global economic developments offer an opportunity to introduce products utilising up-to-date knowledge in a cost-effective manner. In any oil and gas project, it is essential for the senior project management practitioners to apply innovative knowledge management solutions (Reid *et al.* 2001; Corso *et al.* 2001). According to Abdul-Aziz and Lee (2002), the oil and gas industry has taken advantage of knowledge management developments for more than a decade. In that time the industry, has gone through rapid changes and so many mergers that a one worded petroleum company name now seems like an oddity. As established from the reviewed literature (Leavitt, 2002), throughout the rapid advance of technology, an extension of offshore drilling, numerous acquisitions, the growing reliance on foreign oil sources, and a focus on environmental issues, knowledge management initiatives have played a part in making operations more effective and efficient in developed and developing countries (Gallupe 2001; Meier, 2010). Enhancing knowledge-based management systems remains an aspiration with the oil and gas industry.

As suggested by Abdul-Aziz and Lee (2002), when oil and gas companies have been faced with new technology, outsourcing, new partnerships, and government regulations, their knowledge management teams have provided support through technology and knowledge transfer, as well as asset management. When business issues involved capacity management, cost reduction, and the environment, knowledge management played a part through forecasting/scheduling and process and technique innovation (Reid *et al.* 2001). In addition, knowledge management initiatives have expanded to address point-of-sale technology adoption and procedure effectiveness. As established in this research, knowledge management is not a novel concept but an existing knowledge management infrastructure has been found to be a cost-effective means of addressing new and/or increasingly operational issues in the oil and gas sector, including: retaining valuable

knowledge during a period of work force aging/diminishing and increasing efficiency through communities of practice (Leavitt, 2002; Mckenna and Wilczynski, 2006).

According to Rabiu (2009), the global oil and gas sector has been a catalyst to the economic advancement of many nations in the last four decades. Globally, a number of oil producing countries are grappling with key global energy challenges which include providing access to modern energy at optimum cost. As suggested by Rabiu (2009), the industry, particularly the upstream sector in Nigeria has been growing. There is therefore a need to integrate optimally extant capability (i.e. people and technology) for business profitability and long-term sustainability of the society in Nigeria (Rabiu 2009). Recent evidence suggests that (Al-Busaidi and Olfman 2017; Bridge and Wood 2005; Furner *et al.* 2009; Kasimu *et al.* 2012; Oyejide and Adewuyi 2011; Rabiu 2009), knowledge management is a key aspect of organisation capability that is critical in deploying best available resources. For instance, Rabiu (2009) found that the globalisation of the knowledge-based economy will increase knowledge management requirements in strategic alignment with the organisation objectives. As noted by Rabiu (2009), oil and gas organisations in Nigeria have committed more time and resources to leverage the value of knowledge management practice for their organisations. There is, however, a lot more work to be done to make the right impact.

Additionally, there is a need for increased research efforts in understanding influential factors that enhance knowledge management practices in the Nigerian oil and gas industry. There is mounting evidence and opinion indicating that knowledge management-based systems have played a part in making oil and gas operations more efficient and effective. According to Mckenna *et al.* (2006), areas of concern in the oil and gas sector include knowledge management, supply chain, sourcing, project planning, commissioning and engineering. Given the uniqueness of knowledge management-based systems this study presents a balance between the experiences of senior project management practitioners from a developed and a developing country. The outcome is an integrated knowledge management framework that should be of benefit to senior project management practitioners in Nigeria and to a broad range of professionals delivering oil and gas projects. Oyejide and Adewuyi (2011), showed that the dearth of linkages between the oil sector and other sectors of the Nigerian economy is a critical developmental problem. Oyejide and Adewuyi (2011) suggested that one reason why there are no linkages in the oil sector is the capital intensive nature of oil sector activities and scarcity of capital as well as local expertise. Thus, despite several government development initiatives including promotion of indigenous ownership, articulation of local content policy, local content remains insignificant (Kasimu *et al.* 2012; Oyejide and Adewuyi 2011; Rabiu 2009. This problem has contributed to crisis in the Niger-Delta region (Oil and gas region) which remains under developed (Oyejide and Adewuyi

2011). As demonstrated by Rabiu (2009), the key challenges particularly in the Nigerian oil and gas sector are as follows:

- Commitment and alignment-securing commitment by top management to deploy knowledge management tools is a challenge;
- Technology-the level of internet penetration and impact are some challenges in managing knowledge management in many oil and gas organisations in Nigeria;
- Return on investment-measuring the value of knowledge management to the organisation is not considered a priority but could significantly improve resource commitment and confidence level. Many organisations in Nigeria avoid measuring impact and effectiveness because it is not an easy task and not exact science;
- Development of knowledge management professionals-learning and development (and organisation design) professionals who manage the process must be provided skills building opportunities;
- Engagement (interaction) culture-the engagement culture, whether it is open or closed, friendly or hostile, willing or unwilling to learn (i.e. learning organisation) will influence progress with knowledge management deployment.

As established from the reviewed literature, a vast literature related to oil and gas project delivery are invariably written based upon Western practices (Reid *et al.* 2001), and all too often assume that best practice is the Western Way. However, senior project management practitioners in developing countries need to be fully aware of the environment within which they operate to ensure the project way of working is efficient and effective. The need for senior project management practitioners in the Nigeria to successfully incorporate knowledge management based systems is a critical success. Research on knowledge management based systems in fraternity Nigeria is limited (Zuofa and Ochieng 2015). Limited attention has been given by the oil and gas research community about the necessity to take account of enhancing knowledge management practices in Nigeria. Hence, the research scope was thus expanded to include practitioners from the UK oil and gas sector.

1.4 Perspectives of knowledge management in the oil and gas sector

Oil and gas organisations have always managed their knowledge in some form. They have always relied on the expertise of key members of staff. Thus, knowledge management is not entirely new to the industry. What is new is the application of the terminology and the increased awareness that knowledge should be management in a more structured manner. This has been largely brought about by a number of factors such as the: increased global competition; big data analytics; company size; geographical spread; and employee turnover

(Carrillo, 2004, Rovik, 2016). Mertins *et al*. (2001) highlighted knowledge management's ability to improve organisational goals and therefore its close connection to business processes. They considered knowledge management: provides an understanding of markets, customers, develops visions and strategies, develops products and services, improves marketing and sales, improves the production and distribution of and products and/or services. In addition, as illustrated in *Table 1*, Carrillo identified the top ten improvements achieved through knowledge management.

Table 1: Improvements through knowledge management

Rank	Improvement
1	Cost/time reduction, increase in productivity
2	Process improvement
3	Improvement in the exchange of information
4	Customer orientation and satisfaction
5	Transparency of structures and processes
6	Facilitation of decisions and predictions
7	Quality improvement
8	Staff quality and satisfaction
9	Success, market leadership

Source: Carrillo 2004

The increasing size and the geographical spread of oil and gas organisations have led to large, international organisations that make it difficult to source expertise quickly or indeed know what expertise is available within the organisation (Ochieng *et al.* 2013). The high turnover of employees means that there is a need to provide clients with confidence that the organisation is competent in specific areas of work (Kopman and Gupta, 2014; Burstein and Linger, 2003). To facilitate knowledge sharing in an organisation, it has to focus towards human resource policies, information policies, group dynamics, departmental cooperation and organisational incentive structure and any other relevant activities according to the nature of the process involved (Ramanigopal, 2012).

In the oil and gas sector, knowledge management can be thought of as either a framework or an approach, which will enable the development of a set of practices to collect and share knowledge. In balancing information culture and technological culture, there are three major resources named people, process culture and technology which can enable the organisation to utilise and share the information effectively and efficiently towards the betterment of the organisation, where the oil and gas industry cannot be an exception. McKenna *et al.* (2006) noted that the oil and gas upstream industries operate based on the strength of their natural

resources, infrastructure, processing facility and technology, human resources and the most important, energy products that the market demands. If one of the factors fluctuates, it affects the industry operations, planning and production. By nature everything is not exceptional, there are strengths and weakness, resources without capital, knowledge without management, skilled people without organisation, willingness to do but lack of technology, strength in execution but with no quality, no core know how, success with no sustainability, vision with no decision making, and so on and so forth (Ramanigopal, 2012). To be successful, it is important to make use of the best available resources. Everyone could be a master in their own domain but to be a master of all in a particular capital venture, one needs to understand all available data collectively as teams and groups by analysing, sharing experience, knowhow and knowledge.

In the current global context, oil and gas organisations in Nigeria are in need of knowledge management implementation as a key strategy to handle the global competition and to improve their competence to meet the challenges in their business irrespective of the size of the organisation (Kasimu *et al.* 2012; Oyejide and Adewuyi 2009; Rabiu 2009). Knowledge and data management has become the most essential key strategy for the upstream oil and gas sector (Feblowitz and Vesset, 2013; Carbonera *et al.* 2015). From the reviewed literature, it has been established that organisations in the oil and gas sector were early users of knowledge management, and have provided the way in terms of knowledge management implementation (McKenna *et al.,* 2006).

The energy sector incorporates a huge variety of organisations, from oil and gas majors, to conventional, renewable and nuclear power companies, to specialist drilling, mining firms and all allied industries (McKenna *et al.,* 2006). It is an industry dominated by a number of huge multinational organisations, each of which must contend with the difficulties and challenges of maintaining a geographically dispersed workforce, operations, and functioning according to clearly defined operational procedures (OGER 2012; 2013). At the same time, they must cope with external pressures relating to deregulation, growing environmental concerns and strict health and safety guidelines (Ramanigopal, 2012). It is therefore not surprising that some of the world's biggest energy organisations were early pioneers of the principles and working practices of knowledge management and, indeed, still lead the way on a global scale. That said, most energy companies are still to realise the full potential of the resources at their disposal and have not understood the importance of knowledge management and its fruitfulness, and knowledge management represents a powerful means for these firms to deal with the challenges that lie ahead and growing endlessly according to the techno and social changes (McKenna *et al.,* 2006; Ramanigopal, 2012; Ko and Dennis 2011; Robert *et al.* 2008).

A centralised knowledge management system helps companies hasten their effort to backfill their technical capability gap (Corso *et al.* 2001; Reid *et al.* 2001). This also helps to recognise and anticipate problems and avoid these problems across multiple projects. Knowledge management includes on the job mentoring, structured training, and the establishment of institutional mechanisms to capture and disseminate information relevant to project teams (Rovik, 2016). Oil and gas organisations in Nigeria have always managed knowledge in one form or another, usually by relying on the expertise of one key member or another. This shows that knowledge management is not an entirely new concept in the Nigerian oil and gas industry, but there is the need to create an awareness of the terminology and to develop a structure that enables proper knowledge management implementation. Oil and gas organisations in Nigeria, are facing a lot of operational challenges, in handling data required to operate as well as to execute in their business activities (Oyejide and Adewuyi 2009; Rabiu 2009; Shell, 2014). As recommended by Jegede *et al.* (2013), seamless data and technology transfers can be realised by encouraging local contractors, multinational organisations and government to form consortia in order to ensure that proper training is available and taken up by prospective members of the workforce and potential entrepreneurs. However, to achieve this, both knowledge management and effective knowledge management systems play a critical role in the success of such collaborative networks. This is because information sharing and knowledge assets are crucial in the ever-changing and competitive oil and gas industry market. Lessons learned systems are crucial for delivering performance improvement in the risky and expensive world of the international and offshore major projects.

Discussion forums, have become more and more vital for connecting people in communities of practice, and these can usefully be supplemented by real-time collaboration technologies (Nissen 2005; Wagner and Majchrzak 2006). The major benefit that knowledge management has given oil organisations so far is protecting the base. The objective is on reducing capital and operating costs, increasing utilisation and up time, and improving market positioning to compete in the global market. Knowledge is captured and shared about topics such as increasing success in finding oil fields, reducing maintenance down-time in oil refineries, and increasing the speed of build of gas stations. Culture related knowledge management has become more and more popular (Ochieng 2009; Ochieng *et al.* 2013; Zuofa and Ochieng 2015; Ovbagbedia and Ochieng, 2015). Economic conditions remain tough due to cut throat competition, globalisation, strategic operations against competition both local and global level (Ochieng *et al.* 2016). Web Portal has become the most essential tool in the energy sector. Organisations in energy sectors operating at international level started developing

and applying required portals to keep a transferable database of reservoir engineering techniques.

From the reviewed literature a number of broad conclusions were drawn. These conclusions gave a suitable context to the research aim. Enabling oil organisations in Nigeria to capture, share and apply the collective experience and know-how of their project teams was seen as fundamental in this study. Consequently, there has been a wave of enthusiasm and activity centred on knowledge management. To make progress, issues of technology, processes, people and content was explored. Growing global operations in oil and gas organisations is leading knowledge and content management challenges. Oil and gas organisations in Nigeria are being forced to rethink and redesign their knowledge management strategies so as to be responsive to evolving market dynamics, such as technological innovations, (mobility, wireless communication and geographic information systems). There is little doubt that knowledge management has contributed substantially to the companies' success in dealing with challenges of the past decade. As shown in the reviewed literature, oil companies in the West (*for instance UK*) have already taken steps to facilitate knowledge management initiatives (Edwards, 2008). However, despite the amount of resources invested in these systems and the inherent value of knowledge capital, traditional knowledge management initiatives have failed to facilitate access to this reservoir of knowledge assets. Traditional knowledge management initiatives have failed primarily because of (Gartner, 2013; Hart *et al.,* 2013):

1. *Current emphasis on mining instead of using knowledge* - there is limited discussion on facilitating the sharing and re-using of knowledge output that ensues which resides in different systems, locations and disparate formats to generate the radically better outcomes.

2. *Knowledge management systems currently function as operational tools* - as a result of being used primarily to store, retrieve and extract data and information, knowledge management has been relegated to an operational rather than asset management function. Consequently, search is viewed merely as a commoditised retrieval tool—often for non-structured data—although it has the ability to generate radically greater returns when used as a knowledge-sharing and re-utilisation tool.

3. *Current focus on accessing explicit knowledge but not tacit knowledge* - while knowledge management systems provide avenues for employees to access explicit knowledge, it has limited success in helping employees find and access tacit knowledge. This is mainly

because the link between talent management and knowledge management has yet to be fully established. The next section details the research method and symposium of key findings drawn from the participants. This is followed by a discussion, conclusion and recommendations.

1.5 Method

A literature review was performed to determine what is known about the specific research problem of knowledge management based systems in Nigeria and the UK. The review was conducted into a variety of project management disciplines. From the foundation of the review, a research problem was defined (strategies and practices that could be used to address knowledge management issues and enhance project delivery in Nigeria), thus determining the direction of the fieldwork. This procedure is in line with the purpose of literature control, as defined by May (2002), who indicated that literature should assist the researcher in planning the narratives for the actual research. It also enabled a fair evaluation of the research topic through a trustworthy, rigorous and auditable process. The literature review for this study defined some of the possible causes of knowledge management complexity that were involved in oil and gas projects. Through the literature, this study defined qualities of responsive management that are conducive to minimising knowledge management complexity within a project environment. More specifically, this research attempted to pinpoint knowledge management strategies necessary to enhance project delivery in Nigeria.

Considering the aim and objectives of this research and given little was known empirically about the strategies and practices which contribute to improved performance, innovation and continuous improvement in the oil and gas sector qualitative method was used. The literature search revealed that there were already external factors, which influenced the implementation of knowledge management strategies on oil and gas projects in Nigeria (Ekemena, 2011; Nwafor and Salau, 2009). These factors were assumed as integral to everything, which took place in the projects but rather than attempting to make the connections between the two explicit, the study focused on the experiences of the individuals involved in oil and gas project delivery. This opened up the possibility of developing a clear understanding of strategies and practices that could be used to address knowledge management issues and enhance knowledge management based systems in the Nigerian oil and gas industry.

A preliminary pilot study was carried out with experienced project managers in Nigeria and UK. The purpose of the pilot study was to assess clarity of questions, timing, and suitability of the respondents for the study and to establish its reliability and validity. The interview schedule included closed and open questions. The purpose was to obtain rich data about attitudes, opinions, and experiences of people involved with oil and gas projects. The interviews were solely conducted by the researchers. Adopting a semi-structured questionnaire with topics as opposed provided maximum flexibility during the interviews. The major strengths of the semi-structured interviews were found in its usefulness for understanding the meaning and context of the phenomena of knowledge management and the particular operations and processes that make up these phenomena with the oil and gas industry. Specifically, probe questions were used to understand what the participants were saying; exploratory questions were designed to ensure that participants gave as full an answer as possible. This study considered knowledge management based systems across a variety of organisations and project environments. The use of a series of semi structured interviews allowed the researchers to elaborate points, which were unclear to participants. It also enabled the researchers to clarify meaning of questions and provided the opportunity to introduce the research topic and motivate the respondents to provide honest answers. Additionally, it provided the opportunity to explore some issues and allowed the researchers to classify (or at least) clarify the responses to such questions into useful categories during the course of the interviews. The semi-structured interviews were used to derive senior managers' constructs of project delivery efficiency and knowledge management based systems. The method employed helped to evaluate senior managers' attitudes and perceptions as well as to refine and improve the development of the framework.

In total, twenty-six interviews were carried out with senior managers: thirteen in Nigeria and thirteen in the UK. Questions were asked to elicit knowledge management based systems implementation on oil and gas projects. At the start of each interview carried out in this study, participants were advised to read and to sign a statement of consent. The statement of consent briefly highlighted the purpose of the research project, and then explained that the interviews would take the form of a structured discussion. The consent form also assured the participants of complete anonymity during the research process. One of the key advantages that emerged after the interview process is that the sample size used for this research allowed the researcher's to focus on social issues in different types of projects. This was particularly important because the research subject is in a research area of which there was little available data in Nigeria and UK. The following is a summary profile of the twenty-six managers involved in this study [*see Table 2*]; for the purpose of confidentiality, the researcher's used alphabetical letters to represent names of participants.

Table 2: Summary profile of participants involved in this study

Participants	Country	Sector	Current Job	Numbers of years worked in sector	Number of years managed projects	Role and Responsibility
A	UK	Energy	Project Manager	29	17	Managing projects
B	UK	Energy	Project Leader	18	7	Planning
C	UK	Energy	Project Manager	27	15	Managing projects
D	UK	Energy	Chief Project Manager	19	10	Managing projects
E	UK	Energy	Project Manager	12	5	Planning
F	UK	Energy	Junior Project Manager	10	4	Managing projects
G	Nigeria	Energy	Chief Project Manager	14	6	Managing projects
H	Nigeria	Energy	Project Engineer	20	10	Co-ordination of project work
I	UK	Energy	Project Engineer	15	7	Managing projects
J	UK	Energy	Project Manager	20	10	Managing projects
K	UK	Energy	Junior Project Manager	15	6	Co-ordination of resources/technical assessment
L	Nigeria	Energy	Project Manager	20	11	Managing projects
M	Nigeria	Energy	Project Leader	14	3	Co-ordination of work
N	Nigeria	Energy	Project Engineer	17	5	Managing projects
O	Nigeria	Energy	Project Engineer	15	6	Managing projects
P	Nigeria	Energy	Project Leader	11	5	Co-ordination of work
Q	Nigeria	Energy	Project Engineer	19	9	Managing projects
R	UK	Energy	Project Engineer	20	11	Managing projects
S	UK	Energy	Project Manager	23	9	Managing projects
T	Nigeria	Energy	Project Manager	25	11	Managing projects
U	Nigeria	Energy	Project Manager	15	11	Managing projects

Denzin and Lincoln, (1998) noted that interviewee variety is essential to the profundity and richness of data obtained in qualitative research. The aim of this was to explore expert views from successful project directors, project managers, and project engineers on knowledge management based systems within the Nigerian and UK oil and gas sector. The main advantage of this sample was that each participant had worked on projects in developing countries. The participants worked in various types of organisation formations and project arrangements. All participants were considered to have practical understanding of knowledge management based systems and their views were considered those of knowledgeable practitioners. Participants were selected using purposive sampling as the process involves obtaining all possible cases that fit particular criteria and selects cases with specific purpose in mind (Neuman, 2006). Usunier (1998) stated that where researchers want to compare across cultural contexts, they need to use concepts and research instruments that are understood in similar ways. In all cross-cultural studies, as in this study,

the researcher's made sure that the same data collection procedures did not result in biased findings. The search for equivalence was the most important methodological aspect in this research. In order to define a sampling procedure for this research, the researcher's selected a method, which was based on several national or cultural samples, each being fully representative of the populations of the country. The sample was designed to obtain Nigerian and UK participants with the requirement of having experienced positive impact of knowledge management based systems on oil and gas projects. The second requirement for selection was that participants had successful managed complex project teams, and the third requirement was that participants had worked on complex oil and gas projects. As the research participants had not been randomly selected no claim can be made of achieving representation of the wider oil and gas industry. This research instead achieved an in-depth insight into knowledge management systems within the oil and gas industry by interviewing participants' with in-depth project management experience. Interviewing various oil and gas professionals allowed the researchers to analyse and cross-compare all interview responses.

The organisations were selected from a diverse oil and gas sector to ensure that a variety of project environments would be examined. Interviewing more than one project leader in an organisation allowed more information about their actual practice (and opinions) to be obtained. In order to investigate the factors that influenced knowledge management based systems it was necessary to have a range of organisations in terms of projects managed. The organisations that were selected, where twenty-six of the participants interviewed, operated in the energy and petrochemical sector. The selected organisations were well balanced in terms of oil and gas projects managed. In general terms, there was a link between the existence of project work and the type of projects undertaken. To ensure that appropriate recruitment of senior managers, various organisations were contacted. The gatekeepers included company directors in Nigeria and the UK. Between them, these individuals allowed access to their senior project management personnel.

In any qualitative research, data analysis becomes an ongoing process; meaning that the researcher has to make thoughtful, informed decisions throughout the data collection procedure Bryman (2004). According to Lewis and Ritchie (2003), the thread of analysis is woven through the interview process, when the researcher starts to record 'personal comments' beside the narrative data. During the analysis, broad themes and patterns are looked for, rather than narrow, precise variables of qualitative research (Bryman, 2004). As possible topics become evident, the researcher may try to verify the research area during the interviews. For this research, data was not a distinct stage of the study. Formally, it started to take shape in analytic notes; informally it was embodied in thoughts, ideas,

hunches, and emergent concepts and continued into the writing up process. Even though the data analysis phase was placed after the fieldwork phase, the data analysis phase was an ongoing process of fieldwork itself, rather than as a final stage in a linear model. Qualitative researchers (Bryman, 2004; Denzin and Lincoln, 1998; Huberman and Miles, 2002; Silverman, 2001) stress the continuous interconnection of fieldwork and interpretation. Bryman (2014) addressed it as a spherical sequence, whereby the researcher's original theoretical position is continuously altered or refocused by the fieldwork in a dynamic dialectical method.

All interviews were recorded and transcribed verbatim and they were then analysed through the use of a qualitative analysis software package NUDIST NVivo™. During the analysis, broad themes and patterns were looked for, rather than narrow, precisely variables of qualitative research. One of the primary functions of this software that emerged was the ability to add memos to sections of the data, as thoughts and connections were made during all phases of the data analysis. It enabled the researcher's to sort through the data and at the same time allowed exploration for patterns and recurring phenomena. This allowed the researcher's to compare, contrast, and synthesise. Data was then first coded, searched according to codes and the underlying themes and patterns revealed. Initial and subsequent impressions and thoughts were recorded in detail emphasizing the organic nature of this method for data analysis. As the data analysis progressed, further details were obtained, with sections of data intensively analysed. At this stage, the researcher's had already generated some categories through the ongoing theoretical reflections and applied these for initial coding purposes, refining and extending the categories as they went along. In some cases, a particular section would fall into more than one category, but this seemed to indicate the interlinking of themes rather than a fault in coding.

As the analysis progressed, the researcher's developed working categories that explained knowledge management complexity on project teams. Following the construction of a category, the next component of the process was the presentation of the data in a narrative form supported by evidence from the statements recorded during the interview phase and making theoretical references as necessary. The generation of themes was an ongoing and development process, garnered in part by the application of a large number of codes. Four main parent codes (or clusters) provided meaningful categories. These included: knowledge management technology approaches (KMTA), knowledge management people approaches (KMPA), knowledge management strategies and value enhancing practices.

As illustrated above, there was a logical progression to the order of the parent codes. This was an attempt to ensure that the main objectives of the research were met. Once this

phase was complete, the researchers took each topic in turn and inserted the relevant interview extracts. Validity and reliability were achieved by first assessing the plausibility in terms of already existing knowledge on some of the knowledge management issues raised by participants. The verification took place after the interpretation of data; this involved presenting the framework to the main participants of this study in Nigeria and the UK. This was achieved through workshops and group discussions. These workshops enabled the framework to be continuously adjusted and refined. The main purpose of this process was to ensure that the framework that was developed was not influenced by the researcher's own interpretation and thus distanced from the reality in question. The validation took place after the verification process; this involved presenting the proposed model to a different group of managers who were not involved with the study. This was achieved through a focus group. In general, verification and validation was carried out to achieve the following objectives, which follow on from the key objectives of the research, to: present all information compiled throughout both the preliminary and main study stages, ensure that the proposed framework fulfils the requirements of oil and gas organisations, validate the applicability of the proposed framework in real life situations and achieve an agreement on framework requirements to ensure generic applicability.

Rigour was achieved by focusing on verification and validation; this included the responsiveness of the researchers during the fieldwork, methodological coherence, sampling, data analysis and thinking practically. Fitzgerald and Howcroft (1998) considered the existence of relativist and realist ontological positions, where at one extreme there is the relativist position, which holds the belief of the existence of multiple realities as subjective constructions of the mind where the perception of reality is directed by socially transmitted teams and can vary according to language and culture. In this reality, concepts such as right and wrong, goodness and badness, truth and falsehood cannot be absolutes as they can change from culture to culture and situation to situation. At the other extreme there is the realist ontological position, which is based upon the belief that the external world comprises of pre-existing hard and tangible structures. These structures exist independently of an individual's cognition and ability to acquire knowledge, which is a practical position unconcerned with an abstract or idealistic view of life. At the ontological level, this research is common with many other studies and is based upon the realist position. However, this research takes the form of critical realism, which is a philosophy of science that prioritises ontology over epistemology in the sense that, for critical realists, the way the world is should guide the way knowledge of it can be obtained. Critical realism was derived mainly from the work of Bhaskar (1998) and developed by Fleetwood and Ackroyd (2004) and Reed (2005) for organisational and management studies. The interpretivist epistemological position,

which advocates the absence of a universal truth, places more emphasis on the realism of context and is considered critical to apply a scientific model to social study. The understanding and perspective of and interpretation by the researcher of research findings become the point of reference. As such, it is not possible for the researcher to be strictly neutral when adopting an interpretivist epistemological position in research. For example, researchers become totally involved in their research, and their values and beliefs likewise become the driving force in interpreting research findings (Bryman, 2008; Fitzgerald and Howcroft, 1998).

Moreover, when researchers adopt an interpretive approach they start their research with the assumptions that access to reality is only through social constructions such as language, consciousness and shared meanings. Researchers have to try and understand phenomena through the meanings that people place on them because interpretive research focuses on the holistic complexity of decision-making as situations evolve rather than placing pre-ordained definitions upon dependant and independent variables (Easterby-Smith *et al.,* 2008; Remenyi *et al.,* 1998). From a philosophical viewpoint, at the ontological level, this research adopted the realist position because the number of ways Nigerian oil and gas project managers' work on oil and gas major-projects varied considerably. Moreover, this research also considered that the investigation should be conducted in a practical rather than abstract way. In addition, it was essential to investigate the actual project delivery strategies in the oil and gas sector. At the epistemological level, this research adopted the interpretivist position because the nature of the research problem was focused on examining the extent to which knowledge management strategies contribute to adding value in oil and gas projects in Nigeria. The second epistemological level was linked to proposing solutions to knowledge-based management challenges in the Nigerian oil and gas industry. Moreover, Seymour *et al.* (1997) emphasized that the interpretive approach is valuable for identifying problems in the oil and gas sector because it can recognise the differing viewpoints of various people in the industry. In this study, interpretivism was associated with the philosophical position of idealism, and was used to examine diverse people and technology approaches. The adoption of interpretivisim, allowed the researchers to examine culturally differences in organisations in a great level of depth.

1.6 Findings and framework development

This section focuses on the findings, verification and validation of the framework. The framework delineates the key variables that influence knowledge management technologies and people approaches and highlights how knowledge management strategies and value enhancing practices can be managed and implemented. The framework was developed from the key variables identified from the qualitative analysis. As suggested by the participants, it guarantees the correct functioning and enhances creativity and innovation. The implementation of knowledge management based systems is likely to depend on the establishment of a number of identifiable knowledge management technologies and people approaches practices. As illustrated in *Figure 1*, these were found to fall within the following categories: KMTA (Theme1), KMTA (Theme2), KMTA (Theme3), KMPA (Theme1) and KMPA (Theme2).

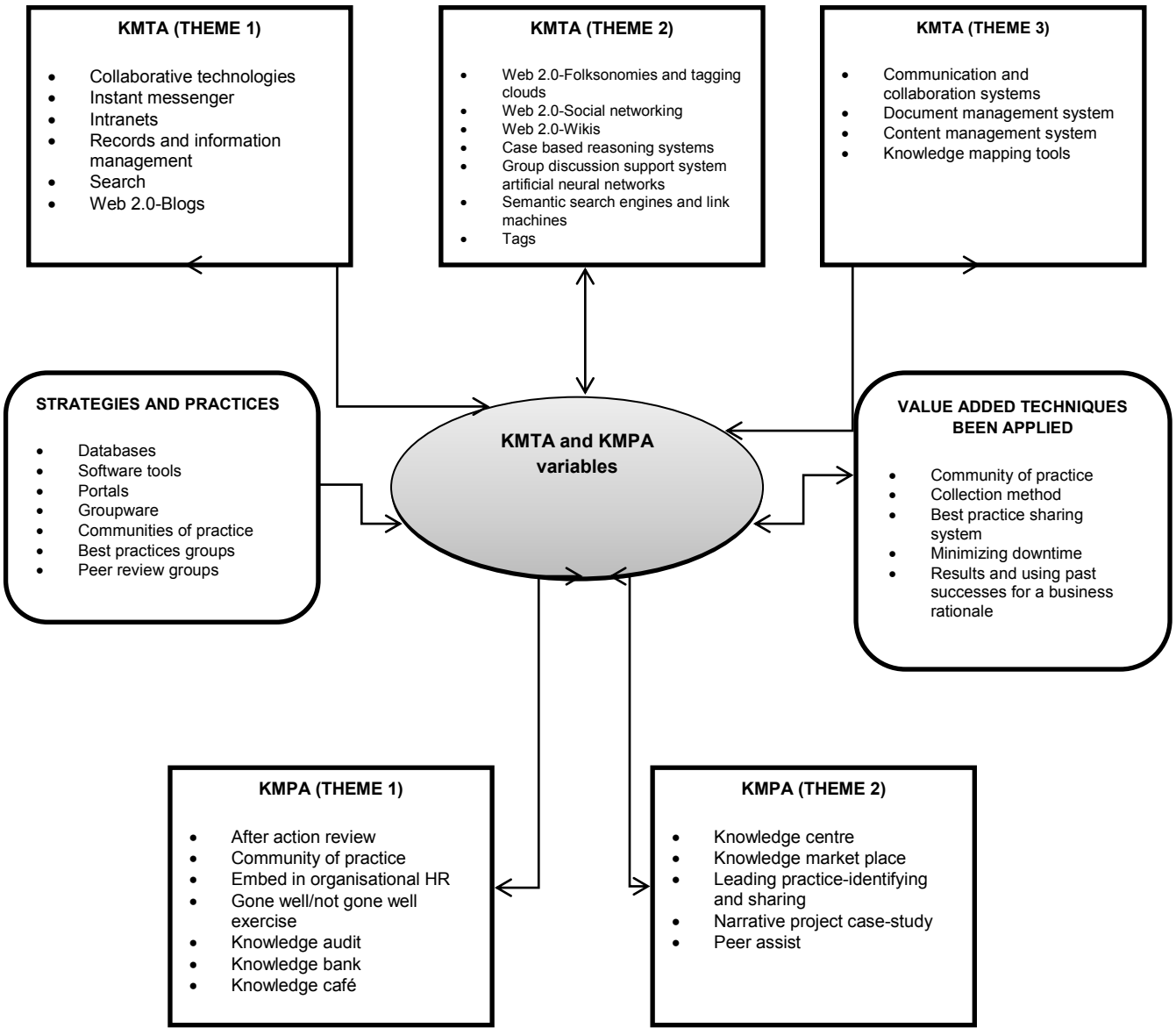

Figure 1: Knowledge management technology and people approaches variables

Conclusions from the qualitative findings indicated that knowledge management based systems represents a powerful means for oil and gas organisations to deal with project challenges. It was also established that enabling organisations to capture, share and apply the collective experience and expertise of their practitioners is seen as fundamental to competing in the global knowledge economy. Participants further suggested that oil and gas organisations embrace good enough technology to make progress, especially in the transitional business environment of today. In enhancing the above, there was a need to propose a framework that would: highlight key knowledge management technology approaches, highlight knowledge management people approaches and knowledge management strategies and value enhancing practices. Figure 2 summarises the main components of the framework that emerged from this study.

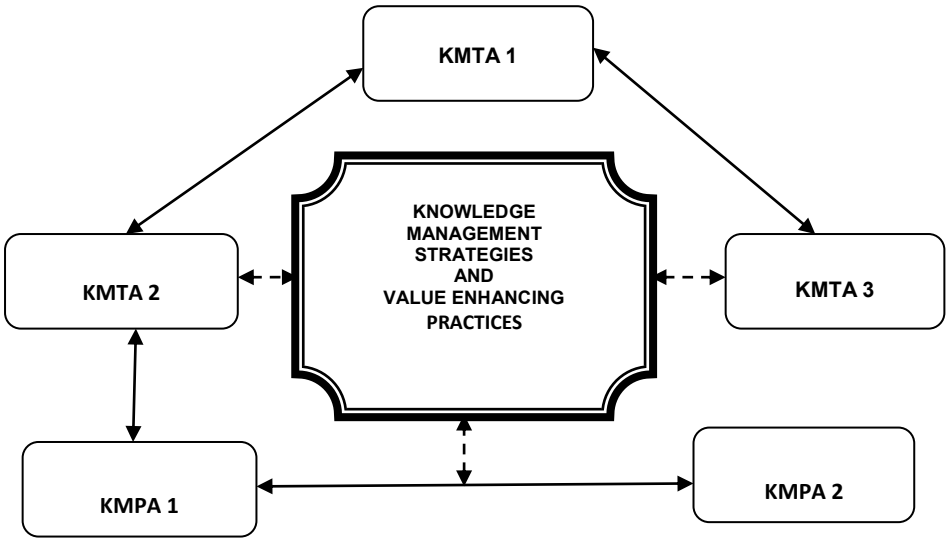

Figure 2: Framework components

The findings show that a framework for knowledge management implementation in oil and gas projects needs to draw together: knowledge management technology approaches, knowledge management people approaches and knowledge management strategies and value enhancing practices. The analysis carried out allowed the researchers to take a step further and propose a more detailed framework (*see Figure: 2*). The results showed that oil and gas organisations must ensure their project teams have access to a library of technical data that comprises of knowledge management technology, people approaches and value enhancing practices.

1.7 Framework verification results

The results of the two focus groups suggested that there must be an evident commitment from senior project management practitioners. This applies at strategic level, operational level and project level. The participants suggested that without guidance from the top, there is a danger of the project team developing their own working culture within the project environment. There was recognition by the participants that in order to build a knowledge sharing culture, senior managers need to ensure that there is a robust knowledge-management platform. As indicated by both sets of participants, the growing difficulties with accessing and leveraging technical project knowledge have roots in several ongoing trends, including demographics. As suggested by the participants about half of Nigerian and UK project engineers are expected to retire over the next coming years. Participants further noted that this exodus could be viewed as a human resource and knowledge management challenge. It was, therefore, not surprising that the key categories that emerged from the verification process as significant were sorted and grouped within the seven main sub-categories of 'knowledge management people approaches', 'knowledge management technology approaches ', and 'knowledge management strategies and value enhancing practices'. These seven sub-categories were found to be inter-connected and thus were reported together.

1.8 Knowledge management technology approaches (KMTA)

1.8.1 Sub-theme 1: KMTA

From the verification results, the UK participants' preferences for and reliance upon instant messenger, search, web 2.0-blogs, records and information was evident, whilst a large majority of participants in Nigeria favoured collaborative technologies and intranets. Interestingly, during the discussion with participants B, G, L, M, C, Z and A, C, E, I, J, R, U in Nigeria and the UK they acknowledged that knowledge management only generates significant performance benefits when it has become embedded in the project cycle and work practices of project team members. It would seem that participants in Nigeria favoured collaborative technologies and intranets because it allowed them to gain more commitment from the project workers. Participants in Nigeria noted that collaborative technologies and intranets are easy to use and their national reach has brought about a fundamental shift in delivery of projects in Nigeria. In the UK, participants favoured instant messenger, search, web 2.0-blogs, records and information. Participants in the UK argued that if you apply the three variables it allows project workers to take real-time decisions on projects. It was also suggested by both set of participants that a single source for aggregated technical data,

internal and external leads to higher adoption of knowledge management technologies approaches identified in theme one.

1.8.2 Sub-theme 2: KMTA

During the interview sessions, there was a consensus that in order to fully implement knowledge management technologies, organisations need to ensure a healthy balance between the business process and project driven approach. Reflecting on their experiences, both set of participants identified 'web 2.0-folksonomies and tagging clouds' as essential to knowledge management technology approaches. The importance of 'web 2.0-social networking', 'case based reasoning systems and 'web 2.0-wikis' gained the highest score in the verification exercise. In the UK participants suggested, that the use of web 2.0-social networking is the most systematic way of analysing relationships between senior managers and project teams. While there is some increase of web 2.0-social networking in the UK, in Nigeria it was found that group discussion support system has mainly been used. As a result, participants from Nigeria noted that they have had to face issues to do with system compatibility. Reflecting on their experiences, participants in Nigeria acknowledged that the use of group discussion support system is vital if oil and gas firms in Nigeria are to address the issue of system complexity. What is surprising is that in this particular category there was a marginal difference between the two groups. Therefore, this suggests that the Nigerian approach does correspond favourably with the UK manner of case based reasoning system, web 2.0-folksonomies tagging and group discussion support system. In order for senior managers in Nigeria to improve on knowledge management implementation, it is vital for the oil and gas sector to alter how senior managers assess the forces for organisational changes.

1.8.3 Sub-theme 3: KMTA

A high majority of the participants affirmed that document management system revolves around a centralised repository that can be used to manage the storage of project data that is vital to the organisation. Participants further noted that document management system enhances the likelihood of delivering a project successfully. During the discussions, participants (S, K, F, D, and E) in the UK suggested that compared to non-electronic systems, the document management systems offer reduced operational costs, improved efficiency and speed of retrieval, improved consistency, and more safety (both in terms of file backups and security measures). In Nigeria, it was found that document management system allows senior managers to exert greater control over production, storage and distribution of project data, yielding greater efficiencies in the ability to reuse project data. During the workshop, both groups highly rated 'communication and collaboration systems', 'content management system' and 'knowledge mapping tools'. The results suggest that there

is a link between the four variables when it comes to the application of knowledge management approaches. Participants from both groups noted that knowledge mapping tools helps you understand the critical success factors, options, and steps involved in implementing a successful knowledge management initiative. Therefore, for this particular category senior managers grouped the variables as follows: document management system, knowledge mapping tools, communication and collaboration systems and content management system.

1.9 Theme 2: Knowledge management people approaches (KMPA)

1.9.1 Sub-theme 2.1: KMPA

In this theme, the two groups differed in a number ways, for instance participants in Nigeria highly rated community of practice compared to the UK participants. Whilst reflecting on their personal experiences, it was observed that the national culture from the two countries differed when it came to the application of community of practice. Participants in Nigeria regarded communities of practice as knowledge integrated into the culture, values and language of the community, whilst a few of the participants in the UK believed that the best learning environments are created when there are real consequences to the project team. It is worth noting that, management must understand the advantages, disadvantages and limitations of communities of practice. As established during the discussions with senior managers, there is more than one type of community. These operate in different ways, are different sizes, have different areas of focus, and address knowledge in different levels of maturity. Four types of community identified by participants include:

- Communities of practice–is a community of practitioners within a single discipline of practice working on a project;
- Communities of purpose-here the community (contractors) is funded by an organisation, and in return commit to project deliverables;
- Communities of interest-consist of primary stakeholders who have a direct interest in the project been delivered; and
- Social communities-consist of secondary stakeholders who have an indirect interest in the project being delivered.

Community is a wide term, and before senior managers consider introducing any sort of community strategy, they have to be very clear about the sort of community they are dealing with. In this category, four variables were highly rated in the verification questionnaire these were: community of practice, embedding organisational human resource, gone well/not gone well exercise and knowledge audit. There was an equal recognition of the importance of the

four variables when it comes to knowledge management people approaches. The only slight difference highlighted was the use of knowledge bank, knowledge café and after action review. In order to manage this particular category, a high majority of the participants suggested a company wishing to introduce the variables identified in this theme, needs to understand that without good communication, rapid exchange of knowledge and best practice within the organization will be difficult or impossible. As illustrated by the two groups in this category, the four variables 'community of practice', 'embedding organisational human resource', 'gone well/not gone well exercise' and 'knowledge audit' are relevant to both the connecting and collecting aspects of knowledge sharing.

1.9.2 Sub-theme 2.2: KMPA

In this theme, almost all the twenty-six participants agreed that knowledge centre, knowledge market place and leading practice-identifying and sharing is essential when it comes to knowledge management people approaches. It was not surprising to see that when participants from both UK and Nigeria reflected on their personal experiences they associated the three variables with effective knowledge management people approaches. The factors emerging from this category indicate that the framework needs to address collective working processes. Combining these requirements with operational considerations, participants (A, C, D, E, F, I, J, K, R, S and W) in the UK suggested that knowledge management requires a managerial approach to mistakes which is healthy and balanced, and which encourages project workers to take certain risks and to be honest about the consequences and their actions. Participants (B, G, H, L, M, N, O, P, Q, T and X) in Nigeria further noted that knowledge sharing and learning is about a two-way communication that should take place in a simple and effective manner. For instance, both set of participants agreed that peer assist and narrative project case study encourages participatory learning. To facilitate the retainment of project knowledge by an organisation, a range of techniques from traditional information management tools and modern tools need to be deployed. In doing this, the effective team working can be achieved at many levels in the project environment. Figure 3 is a representation of the knowledge management framework proposed in this study.

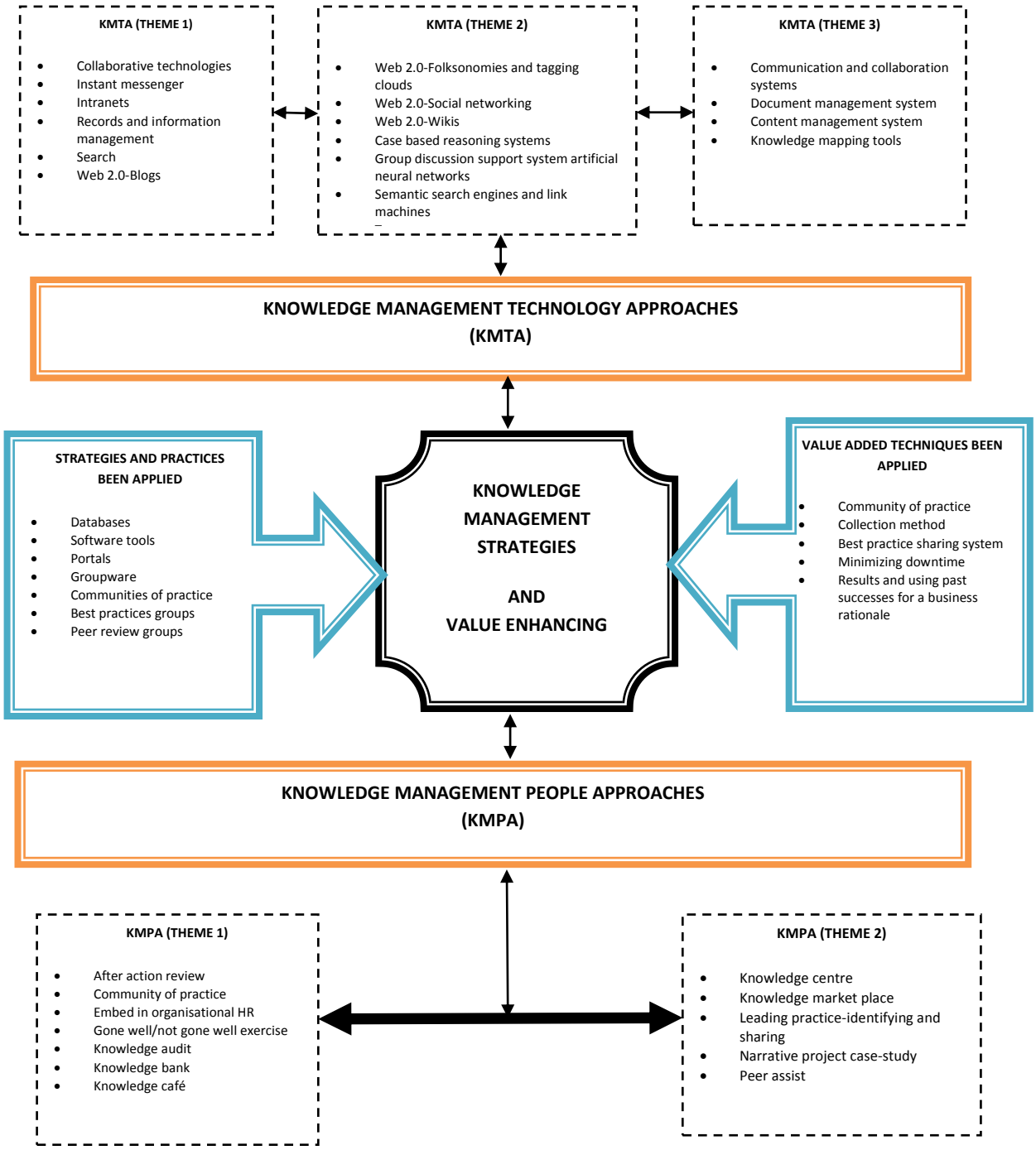

Figure 3: Framework for knowledge management implementation in oil and gas projects

As articulated, the knowledge management framework illustrated in Figure 3 describes how project leaders from Nigeria and the UK perceive importance of knowledge management, strategies and practices, which contribute to improved performance, innovation and continuous improvement in the oil and gas sector. From the qualitative findings, it can be observed that participants felt that the framework highlighted the key factors of knowledge management technology and people approaches that have to be considered to ensure

successful delivery of projects in the oil and gas sector. However, participants (K, L, M, N, O, P, Q, R, S and T) in Nigeria were of the view that though the framework presented useful tools and techniques, training and cultural change would be needed before its full implementation. Participants suggested that a positive cultural change could be created by implementing a series of organisational systems and processes that enhance innovation. Participants from Nigeria acknowledged that the main challenge of knowledge management implementation in Nigeria is getting buy-in from project workers. As established from the qualitative findings, no knowledge management system can work unless senior project workers and project team members fully understand the benefits. In order to weave knowledge sharing and reuse into the everyday workflow of projects in the case of Nigeria, a significant cultural change is necessary. In their opinion, the framework provided a generic application and established a basis for building understanding, and awareness of knowledge management. Reflecting on their personal experience, a majority of participants (A, B, C, D, E, F, G, H, I, J and Y) in the UK agreed that the proposed framework, which could be generally applied, took account of knowledge management technology approaches, people approaches, strategies and value enhancing practices. Participants from UK suggested that a combination of intranet, software, organisational systems and processes forms a successful Knowledge Hub. Results revealed by the verification and validation exercise, suggest that it is essential that researchers in heavy engineering management advance beyond the mere appeal of knowledge sharing studies towards a more complete and detailed explication of knowledge management and organisational processes.

1.10 Framework implementation and barriers

The growing trend in achieving knowledge economy status is giving rise to a need for the development of knowledge management based systems (Rovik, 2016). As established in this study, oil and gas organisations in the Nigeria have recognised that one prerequisite for realising knowledge economy is that they need to invest in modern knowledge management based systems. Hence, the aim of this framework was to enable senior project management practitioners to implement knowledge management technology and people approaches. This framework comprises of: knowledge management technology approaches, knowledge management people approaches, value enhancing practices and strategies and practices. On knowledge management technology approaches, senior managers must ensure that project workers have access to KMTA (Theme 1), KMTA (Theme 2) and KMTA (Theme 3) (*see Figure 3*). Senior managers must also ensure that their knowledge teams have access to a library of technical information that is aligned to processes and systems. In terms of knowledge management people approaches, a comprehensive collection of variables identified in KMPA (Theme 1) and KMPA (Theme 2) should include workflows that automate

ideation and problem-solving approaches. These workflows will help senior managers and other project workers to define and analyse both soft and hard knowledge issues. This will depend on how senior managers integrate the tools and techniques identified in Figure 3. The variables outlined in Figure 3 a framework for how project leaders can think about the return on investment and maximising operational effectiveness.

As formulated in this study, this requires the integration of thinking and practice related to knowledge management. As suggested by the participants much can be achieved by embedding a systematic knowledge management platform, which includes technology and people, approaches. In applying the above, participants affirmed that best knowledge sharing practices can be captured at strategic, operational and project level. The proposed framework has implications for senior project management practitioners who work with project teams and who are committed to enhancing knowledge management practices and productivity. The utilisation of the proposed framework would not instantly transform oil and gas organisations in Nigeria into high performing ones; however, it does identify four key knowledge dimensions that need to be considered. From the above, it is hopefully, evident that in order to develop a culture that is supportive of knowledge management it is necessary for organisations to create awareness, invest in technology, human resource and develop expectation across the three levels of the organisation (strategic, operational and project). As established in this study, senior managers need to be aware of the benefits of knowledge management and give it a priority. During the validation, project leaders affirmed that successful organisations are typically those that have a clear vision, leadership and appreciate the contribution of knowledge to business performance. To ensure the framework is implemented successfully, there has to be: a clear knowledge management strategy within the organisation, awareness of knowledge management, awareness of organisational culture, standard work processes, sufficient funding, and application of technology and knowledge management tools. The above six variables can also be viewed as barriers, hence senior managers need to have effective mitigation processes in place.

1.11 Discussion

The research focussed on the experiences of project leaders in Nigeria and the UK. A number of significant issues have been identified that have not previously been discussed in the literature. The issues that have been identified relate to knowledge management based systems in oil and gas projects. The evidence from this research shows that there is an emerging trend in the development of knowledge management approaches as a research domain (Meir, 2010; Koppman and Gupta, 2014; Hung *et al.* 2015; Yam and Chan, 2015). The discipline is increasingly being informed by the experiences of senior project management practitioners across the world (Mehta and Bharadwaj, 2015; Sarala and Vaara,

2009). On a fundamental level, it was confirmed that senior managers in Nigeria and the UK face similar threats. These threats manifest themselves differently depending on project context. As observed in this study, knowledge management based systems exist because project work in oil and gas projects is increasingly information intensive. This research further established that the value that knowledge management technology and a knowledge-sharing culture can reap is being consistently demonstrated throughout the oil and gas sector in Nigeria and the UK. Collaboration tools in the UK have opened a new era for rapid and easy access to, and interchange with, senior project management practitioners and project workers regardless of where they reside. For example, oil and gas organisations in the UK, expect suppliers to deliver electronic inventories of their products and services as a basis for improving their global operations.

Today's wide variety of oilfield electronic initiatives, some simple and others highly sophisticated, span activities from procurement, as just described, to the acquisition and divestiture of oil and gas assets. Concerning current practice in Nigeria and the UK, the research established that knowledge management based systems remains an unexplored area in Nigeria. It was found that project leaders in Nigeria face different problems from those in the UK. It is worth noting that project leaders in Nigeria face considerable cross-cultural challenges when implementing knowledge management technologies. The most formidable problems senior project personnel face in modifying project management to local needs include procedures, knowledge, and process. As discussed in the validation exercise, if a proper cultural strategy is implemented and managed by properly trained senior project personnel these difficulties can be overcome. The accruing benefits will extend to all the stakeholders involved with oil and gas project delivery in Nigeria. As identified in this research, policy issues are the main ones that face the oil and gas sector in Nigeria, and that policy reforms will improve knowledge management practices. In order to enhance knowledge management practices, local oil and organisations in Nigeria and the government need to work closely.

It was further established that oil and gas project management could be characterised by a two-fold approach: that projects are said to comprise universal characteristics that can be managed with a common approach. Interestingly, there was a strongly held belief that the key to knowledge management based systems integration in oil and gas projects is making sure that organisations or an individual have the ability to adapt, and work with different technologies. Some of the notable differences between participants in Nigeria and the UK were the application of knowledge management practices. The findings showed that senior project personnel from UK have three primary content management initiatives in place:

- The Knowledge Hub-a key feature of the Hub is the seamless view it provides to the end user;
- Real-time News-is a news-based corporate portal hosted on the Hub. As suggested by participants, clients and employees can search, categorise and customise the data; and
- The In Touch Knowledge Hub-provides a single electronic interface for data exchange on oil products and services between the field and its technology centres.

Even though there were some differences between participants in Nigeria and the UK, the findings showed that some of the key lessons drawn from UK participants that could be utilised by participants in Nigeria are as follows: it is important to realise that knowledge management based systems and content management are the tools to help oil and gas organisations reach their business goals, and they are not the solutions in and of themselves; craft a solution that is applicable across the project, and adopt an evolutionary approach as business needs require, rather than assume it will be a one-time technology that can be implemented; putting aside technology and process, fundamentally the people involved in the knowledge and content management effort will really make the difference; the cost of initial content migration is substantial - not only will the company have to migrate existing content, but also much of that content will need to be revisited and revised before it is made available to the company population; and time and money will inevitably be wasted due to failed technologies or technologies that do not live up to their promises. The tools to publish content should be very easy to use.

1.12 Conclusion

This study set out to propose a framework for knowledge management implementation in oil and gas projects. As found in this research, some of the value added techniques used include: communities of practice, collection method and best practice sharing system. It is essential for senior project personnel to ensure that they use internal and external benchmarking to determine what best knowledge practice is when delivering projects. The expansion of the electronic world brings with it major challenges such as computer and information security. What needs to be well understood is that security, confidentiality and protection of proprietary information are vital in the relatively open environment of the Internet. These principles must be honoured because of the immense value of upstream exploration and exploitation data. The research also revealed that effective knowledge management based systems should dramatically increase speed of response as a direct result of better knowledge access and application. The application of more collective and systematic processes will reduce a practitioner’s tendency to repeat the same mistakes.

In relation to strategies and practices which contribute to improved performance, innovation and continuous improvement in the operations of the oil and gas industry in Nigeria, the research identified the main categories that are central to improved performance, innovation and continuous improvement. These are databases, software tools, portals, groupware, communities of practice, best practices groups, peer review groups, knowledge management and human resource training. There is no doubt that knowledge management has constituted substantially to the success of UK oil and gas organisations. Despite the enthusiasm with which organisations in Nigeria have embraced IT-based knowledge management systems to increase value and efficiency, implementing such systems has proven difficult. As shown in this study, successful knowledge management based systems requires the aligning of business strategy, technology for knowledge management, project management strategy with an enterprise-knowledge sharing culture. Such sharing requires managing the behaviour of project personnel such that knowledge transfer becomes part of the organisation's norm.

Being familiar with organisational culture empowers organisations with the requisite knowledge for improving the efficiency of delivering projects. Although the scope of this research was restricted to projects in Nigeria and the UK, the geographical focus of this research does not invalidate these results with respect to other countries. The fact is that the oil and gas sector globally shares some common fundamental characteristics. Nigeria and the UK were simply used as case studies to examine broader issues and problems of the industry. Furthermore participants from the UK have shown that knowledge management infrastructure can be a cost-effective means of addressing new and/or increasingly pertinent operational challenges in the oil and gas sector. If anything, the Nigerian and the UK cases represent an exceptional and a particularly convincing example because they constitute participants from a developed and developing environment.

In general terms, there are similarities in the fundamental characteristics of practice of project management in the oil and gas sector in both Nigeria and the UK. Consequently, there are number of additional factors to be considered. The implementation of knowledge management based systems requires deliberate planning and action to create the conditions for success and put in place the strategy, leadership, goals, process, skills, systems, issue resolution, and structure to direct and exploit the dynamic nature of project work. The strategies proposed in this research cannot be expected to resolve all knowledge management issues in the oil and gas sector. However, their use defines an approach that is superior to the traditional approaches typically adopted and consequently merits far wider application. However, what does this mean for senior managers in Nigeria? The

engagement of employees will require the reformulation of perceptions and expectations about job responsibilities and performance such that knowledge-related activities are accepted as a normal part of the job. In aligning knowledge management strategies with business strategies, senior managers need to identify the following:

- What types of knowledge management based systems are necessary for the organisation viability;
- What data is to be used;
- They need to prioritise and filter their knowledge management based systems depending on how much; the technology would contribute to realising their goals.

The evidence from this study suggests that knowledge accumulation and sharing will occur voluntarily and cannot be conscripted. Knowledge management based systems are only used when knowledge sharing activities are supported by trust and appropriate tools. As established in this research, content management systems of people, processes and technology provide meaningful and timely information to project teams by creating processes that identify, collect, categorise and refresh content using a common taxonomy across the project life cycle. The framework was considered useful for oil and gas organisations in Nigeria since it addressed most of the requirements that are necessary for organisations to achieve operational efficiency. In summary, the proposed framework presents a better way of optimising the performance of project-based operations thus enabling oil and gas organisations to reform their poor performance on projects and empower them to better manage emerging cultural challenges in their future projects.

Following an analysis of the findings, a number of recommendations can be formulated which need to be addressed by the industry if energy demands continues to grow on a global basis. These are: it would be essential for oil and gas companies to collaborate with organisations across all industries in seeking ways to improve overall operational efficiency. As established in this study, communities of practice are the next step in the evolution of the modern, knowledge-based approach to process and productivity improvement.

1.12.1 Limitation of the research

The study has achieved its aim of proposing a knowledge management framework for oil and gas projects. Although the findings may be widely applied, it will be important to conduct follow-up research validating the potential for using the results of this study to establish frameworks for knowledge and information management in different organisations and contexts. This will provide not only data about the validity of the framework in generic terms but will also generate additional data on the application of knowledge management strategy.

There are some issues that were not covered in-depth but have been identified as themes for subsequent research. These issues have been outlined as very specific recommendations for further research below:

- There is a need for the oil and gas industry to develop further its appreciation of the different cultural factors that influence the application of knowledge management strategies. This calls for comprehensive research into value enhancing practices, including the unique features of oil and gas projects, technological characteristics of projects, and socio-cultural differences. The practice of knowledge management within the oil and gas sector will greatly benefit from such studies especially if they not only identify the influencing factors but also establish if any co-dependencies exist among these factors.
- It was established that knowledge based systems have different tolerances for uncertainty. Such considerations need to be taken into account in further research focussing on examining factors that can be used to manage knowledge-based systems' uncertainty in oil and gas projects.
- There is a growing demand for geographic information systems and knowledge based systems to help senior project management practitioners working in emerging economies to deal with large and complex oil and gas projects. Further studies in this area will help the managers to process and analyse large data.

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